FEEDLOT PERFORMANCE AND CARCASS TRAITS OF FEEDER CATTLE SORTED BY HIP HEIGHT AND ULTRASOUND DETERMINED BACKFAT

by

SUSAN CAROL HENDERSON-PERRY

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Larry Corah

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DEDICATION

This thesis is dedicated to the most important people in my life, my loving husband, Randy Perry and my parents, Jack and Nancy Henderson. It was through my parents love, friendship, encouragement and continued support that enabled me to become what I am today. Mom and Dad have always encouraged me to achieve all that is possible and to dream of being more. My best friend, Randy has helped make all of this possible. Without him, I probably would have never finished my degree. He is a special person who brings lasting joy into my life, I look forward to the times we will be together for they shall last forever.

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Introduction

The concept of preferred beef cattle type and body composition has changed markedly over the past 150 years. In the early days of the West, beef cattle were produced and utilized more for their by-products than for edible meat. The monetary value of by-products in early days, e.g., tallow and hides, comprised as much a 75% of the total live animal value. Currently the value of by-products comprises less than 10% of the total of the live animal, and the dressed carcass represents more than 90% (Hedrick, 1972). In the early and mid nineteen hundreds, when steers were finished on pasture, ability to finish at a young age was desirable (Cundiff, 1988). However, when availability of grain feedstuffs increased, we shifted to high concentrate rations, and the ability to fatten early became a handicap (Cundiff, 1988). Yield grades were added to the USDA grading system to reflect variation in carcass value associated with differences in yield of retail product (Cundiff, 1988). This has influenced the type of cattle currently being produced, particularly the amount of fat on finished animals (Hedrick, 1972).

During the past two decades, there has been a marked change in consumer perceptions of what is desirable in beef, the product (Allen, 1988). The consumer is demanding beef be leaner with less external fat. This shift is a result of changes in consumer lifestyles, and an awakening of diet-health concerns on the part of a large proportion of the U.S. consuming public (Allen, 1988). Fat and its role in increasing blood cholesterol levels has come under scrutiny with respect to its role in causing coronary heart disease and other health-related problems (Cross and Savell, 1987). Cholesterol levels are associated with dietary intake of saturated fat with most medical professionals strongly

recommending control of the type and amount of fat consumed in attempt to regulate blood-cholesterol levels (Cundiff, 1988). Therefore, consumer pressure to reduce fat content has intensified.

The year 1986 will be remembered as the year the beef industry "declared war on fat" and perhaps 1987 will be the year we begin to win the war against fat (Cross and Savell, 1987). However, the beef industry's production, processing, and merchandising systems are more oriented to producing beef which is enjoyed by consumers than they are to producing a product that is economical and optimum in nutrition. The basic production system now utilized results in excess carcass fat, and a significant portion is not removed when beef is merchandised (Dikeman, 1984). This excess fat dilutes the protein, mineral, and water soluble vitamin content of beef and increases its caloric content (Dikeman, 1984). Emphasis on low fat diets, including low fat beef, is likely to continue (Dikeman, 1984). Because fat is a rich source of calories, and the need for many people to lower caloric intake, beef should be merchandised with less fat (Dikeman, 1984). If the beef industry is to survive, it will be forced to improve production efficiency, one method to improve efficiency would be to market cattle at an optimum slaughter end point for performance, carcass composition, and acceptability (Parrett et al., 1985).

An accurate and efficient method for measuring body composition, fatness, and loin-eye area in live animals is needed to establish a system that can identify superior livestock without the need of slaughter. It is well known that selection based on individuals' own performance will result in the most rapid improvements when heritabilities are high (Andersen, 1975). In general, carcass traits have high coefficients of heritability, and therefore, it is important to have accurate methods for evaluating carcass quality in live cattle (Krausslich, 1974). Various subjective and objective methods have been developed

to make indirect measurements of the anatomical composition of live animals. Among the objective methods, ultrasound appears to have considerable potential as a non-destructive and relatively accurate method to measure fat thickness and loin-eye area (Andersen 1975).

Cattle Type

Body Type. Changes in our nation's beef cattle breeding herds have resulted in the production of feeder cattle that differ widely in frame size, muscling, body type, and relative ability to gain weight and fatten. Once our herds were basically descended from British breeds, we are now dealing with more than 70 different breeds of cattle (Williams, 1988). In the case of today's beef cattle, ideal type is an animal capable of efficient conversion of feed grains and roughage into the maximum amount of consumer acceptable meat which is physiologically feasible (Hedrick, 1972). Body type, usually designated by breed or lines within breed, influences growth rate and mature body size which in turn dictates animal composition at a given weight or state of physiological maturity (Allen et al., 1976). If all cattle were born as carcasses instead of as calves, the design of breeding programs to optimize retail product would be fairly simple (Gosey, 1986)! The problem is a number of sizeable, dramatic antagonisms between retail product growth and major production traits (Gosey, 1986).

The beef industry is on the verge of "targeting" their production systems to meet these consumer targets (Cross and Savell, 1987). To satisfy the consumer, beef must be tender, flavorful, possess a minimum of waste fat and be priced competitively with other meat products (Hedrick, 1972).

Frame Size. Large frame feeder cattle would not be expected to reach 1.3 cm of backfat over the twelfth rib until their live weight exceeds 546 kg (Williams, 1988). The

larger the frame size, the longer the feeding period required to reach slaughter condition (Long, 1988). Feeder cattle which are small frame are thriftier and would expect to produce a choice carcass with 1.3 cm backfat at live weights of less than 456 kg (Williams, 1988). Heavier carcasses of large breeds were leaner and the lighter weight carcasses from the smaller breeds were fatter (Adams et al., 1973). The percentage of total carcass fat increased linearly across days-on-feed (13.5 to 34.9%) for carcasses from early maturing cattle. However, on the carcasses from later maturing cattle, percentage of total carcass fat increased slightly up to 77 d (10.3 to 15.6%), and remained relatively constant thereafter (Wheeler et al., 1989). Small-type steers were more mature, and graded higher than large-type steers slaughtered at equal ages (Smith et al., 1977). Different types of cattle fed to a constant finish were not different in proportions of water, protein, and ash (Stonaker et al., 1952).

Effects of Days on Feed on Other Factors

Management. Twenty to thirty years ago, we had seven to nine breeds of cattle trying to reach the Choice target. In the 1980's, we have almost 70 breeds trying to reach the target. Many of our breeds today can only reach Choice if fed for long periods, while some may never reach it - - they do not have the genetic ability to deposit sufficient amounts of marbling (Cross and Savell, 1987). We can and should manage cattle of various genetic potentials to best utilize their capabilities, and over fattening to produce USDA Choice quality grade is not the answer (Turner, 1988). Elimination of yield grade 4, and eventually of yield grade 3, will ultimately require combined efforts of the seed stock industry and of feedlot operators.

Average Daily Gain. Zinn et al. (1970a), reported average daily gain increased with increasing time-on-feed, up to 180 days. Dikeman et al. (1985), found no differences in average daily gain between steers fed a high energy diet from 139 up to 242 days. However, Dikeman (1984), concluded the faster growing, heavier muscled cattle were more efficient because they have a higher percentage of retail product at a constant marbling end point. Therefore, reducing fat in slaughter cattle would improve feed efficiency greatly (Dikeman, 1984).

Fat Deposition. Fat deposition in the bovine animal is influenced by the kind of feed and length of feeding period (Johnson et al., 1969). During the growth period, fat is deposited in the following order: 1) around viscera and kidneys 2) intermuscular 3) subcutaneous and 4) intramuscular (Andrews, 1958). Therefore, younger animals have less marbling than would be expected for a specific level of fatness (Lawrie and Kirton, 1956). Data indicates steers and heifers deposited intramuscular fat at a similar rate, and the deposition of intramuscular fat is not a continuous process, but proceeds in a step-wise pattern at 60- to 90-day intervals (Zinn et al., 1970a). Additionally, in the latter stages of the fattening period there was a rapid deposition of intramuscular fat (Zinn et al., 1970a).

Beef breeds began to deposit intramuscular fat rapidly at 10 to 20 mo and dairy cattle gradually marbled without a period of rapid deposition (Lawrie, 1961). In a study looking at growth differences of separable lean and fat from Angus calves slaughtered at 6-month intervals from 6 to 36 mo of age, it was found separable lean weight increased linearly, but on a percentage composition basis, the separable lean leveled off at 50% at about 24 mo. From 18 to 36 mo, separable fat increased from 30 to 37% (Hiner and Bond, 1971).

Extended full-feeding to the point where muscle growth is declining, and fat deposition is increasing rapidly will result in progressively lower yield of salable retail cuts and a progressively higher yield of fat (Hedrick, 1972). The National Program of Research for Agriculture estimated two billion pounds of fat was trimmed from beef in 1966 and fat represented an investment of 500 million dollars in feed costs, by-product value for this fat was 100 million dollars (Hedrick, 1972).

Fat Thickness. The production of excess fat by current feeding and marketing practices substantially increases costs of production, and places beef in a noncompetitive price situation with other protein sources (Dikeman, 1984). As length of feeding period increased fat thickness increased (Smith et al., 1977), resulting in decreased yield grades (Tatum et al., 1980; Dikeman et al., 1985; Parrett et al., 1985). Trimmable fat increased by 681% after a 270-day feeding period, and half of the increase was between 90 and 150 days-on-feed (Zinn et al., 1963). An animal or carcass which is wasty fat will not satisfy the requirements of the retailer or packer (Hedrick, 1972).

Marbling and Palatability. There is increasing concern within the industry that present USDA quality grades unnecessarily emphasize marbling, and as a result encourage over-fattening of cattle and carcasses (NCA, 1981). With the current feeding, grading, processing, and marketing system for cattle, the concept of feeding for muscle growth rather than maximum live weight gain is not yet applicable, and the USDA Choice grade is still the "norm" for the industry. Cattle feeders, meat packers, retailers, and restaurateurs are oriented primarily to the production and marketing of Choice grade beef (Dikeman, 1984).

As length of feeding period increased, percentage of carcasses grading Choice increased as well (Parrett et al., 1985). The length of time cattle have been fed a high-

energy diet has been proposed as an adjunct to or substitute for use of marbling for predicting cooked beef palatability (Dolezal et al., 1982). In a study to investigate effectiveness of days-on-feed, researches reported steers fed grain for 100 days produced steaks as palatable as those from steers fed 130, 160, 200 or 230 days. Heifers fed grain for 90 days produced steaks which were as palatable as those from heifers fed 200 days; thus, extending time-on-feed beyond 100 days for steers or 90 days for heifers provided little additional assurance of eating satisfaction (Dolezal, 1982). Zinn et al. (1970a), reported marbling score and carcass grade increased up to 240 days-on-feed. In a study to evaluate the combined effects of time-on-feed, and diet energy density on the palatability of beef longissimus muscle steaks, little differences in palatability were found (Burson et al., 1980).

In a large group of steers, fed for 100, 130, or 160 days, the palatability of the steaks differed little regardless of quality grade, however, there was a increase in flavor desirability associated with the increase of days-on-feed (Tatum et al., 1980). Tatum et al. (1980), suggested knowledge of feeding history might be a useful adjunct to or substitute for USDA quality grade for predicting beef palatability, and concluded young cattle finished on high-energy diets are similar in palatability despite large differences in amounts of marbling. Days-on-feed were not highly correlated to sensory taste panel scores, however were found to be a good indicator of marbling level (r=.62) (Parrett et al., 1985).

Warner-Bratzler Shear Values. There were no differences in Warner-Bratzler shear values for cattle on feed for increasing lengths of time (Dinius and Cross, 1978). Clark et al. (1976), reported an increase in flavor and tenderness, and a reduction in the Warner-Bratzler shear values when cattle were fed either 56 or 112 days compared to those slaughtered immediately off pasture, however, there were no differences between the cattle

fed for 56 and 112 days. Zinn et al. (1970a), reported shear values decreased early in the feeding period, but increased later in the feeding period. What differences were present disappeared with as little as 56 days of feeding (Burson et al., 1980). Zinn et al.(1970b), reported the triceps brachia muscle became more tender after 90 days-on-feed, and there was no change from 90 to 180 days.

Factors Related to Beef Quality

Subcutaneous Fat Thickness. Animals which deposit excess subcutaneous fat produce carcasses which are less valuable than those which preferentially deposit intramuscular fat (Johnson, et al 1969). Marbling continues to receive primary consideration in the assessment of quality in the current beef grading system (USDA, 1975). Identifying fat thickness as a market end point is one method of minimizing over fattening of cattle, and is a useful marketing indicator because fat level can help predict palatability and cutability, and does influence carcass chilling (Dikeman and Kemp, 1981). Smith et al. (1976) reported increased subcutaneous fat thickness of lamb carcasses caused carcasses to chill more slowly, increased enzyme activity, lessened sarcomere shortening, and improved meat tenderness. Research has generally shown 6-10 mm of subcutaneous fat thickness is sufficient to retard the postmortem chilling process in order to assure beef will be tender (Bowling et al., 1977; Tatum 1978; Tatum et al., 1982).

Steaks from U.S. Standard bulls and steers, and U.S. Select bulls and steers which had less than 7.6 mm of fat thickness were less palatable than steaks from U.S. Choice steers or from U.S. Select bulls and steers that had at least 7.6 mm fat thickness (Riley et al., 1983). Regardless of the amount of external fat, loin steaks possessing modest or above marbling had lower shear values, and higher tenderness and juiciness ratings than steaks containing slight or lower marbling, although mean palatability scores were in the acceptable

range for both palatability traits (Jennings et al., 1978; Dolezal et al., 1982). Feeding cattle of the A-maturity range to higher fat levels to improve meat quality may not be a justifiable procedure because of decreased efficiency in the production of live weight and separable-lean gain, and the costly addition of unnecessary fat (Parrett et al., 1985).

Relationships between subcutaneous fat thickness and the organoleptic properties of beef were neither linear nor additive; fat thickness levels of 7.6 to 10.2 mm provided relatively high assurance of desirable palatability (Tatum et al., 1982). Marbling score increased as subcutaneous fat thickness increased until a certain level for each breed group was reached, where upon it appeared increases in subcutaneous fat contributed little to the addition of marbling (Jeremiah et al., 1970). Compared to marbling, fat thickness was ineffective as a predictor of cooked beef palatability, however, marbling, used in combination with a minimum fat thickness constraint of 7.62 mm for carcasses with a "slight" amount of marbling, facilitated more equitable stratification of carcasses according to their expected palatability than did marbling alone. Tomorrow's retail cuts of beef will have no plate waste and will be from carcasses of the U.S. Good or Choice grade (Cross and Savell, 1987).

Marbling. Degree of marbling in the twelfth rib cross-section of the rib eye muscle is currently the primary determinant of USDA carcass quality grades (Gosey, 1986). Although marbling is positively related to palatability, it accounts for only about 10% of the variation in beef tenderness, and slightly more of the variation in juiciness and flavor (Dikeman, 1984). Some studies have shown a positive relationship between marbling and palatability, especially taste panel ratings for tenderness or Warner-Bratzler shear force, while others have shown a very low relationship (Gosey, 1986). Pearson (1966), concluded the degree of marbling in beef had little or no effect on tenderness but increases in

marbling did improve flavor and juiciness. It was reported there were no differences in tenderness, flavor, juiciness and Warner-Bratzler shear values of beef containing the amount of marbling typical of U.S. Select, Choice and Prime quality grades (Parrish et al., 1973).

Marbling had a low, but positive, relationship to all of the palatability traits of beef (Tatum et al., 1982). Garcia-de-Siles et al. (1977), concluded the emphasis in which marbling receives in carcass grading does not appear to be justified in predicting palatability components in carcasses from relatively young cattle which received a high-energy diet.

In a comprehensive study on the relationship between marbling and palatability of cooked beef, Smith et al., (1984) reported were no differences in loin steak flavor, juiciness, tenderness, overall palatability or shear force value between A-maturity carcasses with slight or small marbling. However, for A- and B-maturity carcasses with small marbling had significantly higher flavor, juiciness and overall palatability scores than carcasses with slight marbling. So, marbling may be more important as maturity advances and is reflected in the USDA beef grade standards (Dikeman, 1987).

Principles and Techniques of Ultrasonic Measurements

History. Ultrasound is defined as any sound above an audible frequency (20,000 hertz), one hertz is equal to one cycle or sound wave per second (Rantanem et al., 1981). The principle of acoustic sensing in medicine, was developed in the eighteenth century by physicians who "percussed" areas of the body to listen for audible differences between fluid filled and gas-filled spaces (Pechman and Eilts, 1986).

In the 1940's, sonar occurred which was used in World War II to detect submarines, it was refined and then used to demonstrate echoes deep within body tissues.

Early in the 1950's, ultrasound was introduced into human medicine (Pechman and Eilts, 1986). It was used to visualize soft tissues and has become an important diagnostic

tool (Wild, 1950; Howry and Bliss, 1952). Utilizing a water path scanner, in which patients were seated in water and a submerged transducer was moved in a circle around the patients, the high-frequency sound waves were transmitted into the body, reflected back, and displayed as a video image.

In the mid 1950's, using A-mode ultrasound, which is a one-dimensional display of echo amplitudes for various depths, scientists began evaluating the fat and lean portions of animals and detecting pregnancy in ewes. However, A-mode was limited because it defined only major differences in tissue densities.

In the 1960's, advancement in technology occurred which allowed the transducer to be applied directly to an animal without the use of a water bath. Images were also improved, however, these black and white images were still limited, as they still only defined major differences in tissue densities.

Electronic scan and gray scale imaging were introduced in the 1970's. Many amplitudes of echoes are represented by various levels of the gray scale; the signals are stored in a scan converter, and then displayed on a television monitor where they can be photographed or recorded on videotape (Rantanem et al. 1981). Gray scale imaging allowed the resolution of more difference in tissue density, and increased the accuracy of the image. Ultrasonography in veterinary medicine was introduced at this time. Most of the work occurred in the area of pregnancy diagnosis in swine, and later used in both sheep and cattle (Pechman and Eilts, 1986).

In the late 1970's, real time or dynamic imaging was introduced. Real time ultrasound allows the operator to observe movements as they occur (Park et al. 1981).

Mechanics. The abilities of ultrasound are based on reflections occurring at tissue interfaces of differing acoustic impedance. Acoustic impedance equals the product of

density of the tissue. Therefore, the principle of ultrasound is based on the abilities of various tissues either to reflect or propagate high frequency sound waves (Pechman and Eilts, 1986). Dense tissues are echogenic and reflect most of the beam, and thus appear white gray on the screen; where as liquids are non-echogenic and do not reflect the beam, therefore, appear black on the screen (Rantanem and Ewing, 1981).

Area Measured. The utilization of ultrasound is a new approach to evaluate intramuscular and subcutaneous fat, and longissimus dorsi muscle in live cattle, sheep and hogs. The ultrasonic measurements of live cattle are concentrated upon the musculature and subcutaneous fat layer in the loin and back (Andersen, 1975). In this region, the musculature consists mainly of longissimus dorsi muscle. A well defined muscle, relatively easy to measure (Andersen, 1975). Additionally, the skeletal features in these regions are easy to locate, so the position of measurements can be reproduced for each animal (Andersen, 1975).

Application. Graders could not rank individual animals on the basis of either quantitative or qualitative carcass traits with the precision necessary for selecting among individuals. They concluded more precise measurements of differences among individuals were needed (Gregory et al. 1964). Ultrasound has been indicated as a tool to increase uniformity of feedlot cattle by using average fat thickness to estimate actual fat thickness. This was found to be more accurate than using individual values (Wood et al., 1986).

Therefore, real-time ultrasound may have a broad application in the livestock industry. The use of ultrasound can be used to increase purebred producers knowledge and use of carcass traits, provide an alternative way of obtaining carcass data at livestock shows, provide an awareness of carcass traits to youth in market livestock projects, allow extension

to use new technology in meeting clientele needs, and provide a method of determining carcass traits on live animals involved in research projects (Turlington et al. 1986). With beef cattle, it takes a long period of time to prove bulls for meat quality and quantity traits through the use of performance and progeny tests (Harada et al. 1985; Wilton et al., 1973), ultrasound offers the potential to drastically shorten this time period.

Cattle, Hog and Sheep Experiments with Ultrasonic Equipment

Animals and Management. The first work with ultrasound on live cattle, utilizing a "somascope", provided a reliable indication of fat thickness (Temple, 1956). Other work found fat thickness and rib-eye area can be accurately measured with ultrasonic equipment as shown by a close relationship of a plotted outline made ultrasonically of the live animal with a tracing between the 12th and 13th rib of the carcass (Price et al., 1960). A similar technique used on live hogs also indicated a close relationship of live measurements compared to carcass measurements (Stouffer et al. 1959). Early work with sheep found low but significant correlations when measuring fat thickness and loin-eye area (Campbell et al. 1959).

Early ultrasonic measurements of lean tissue in hogs did not show sufficiently high relationships with lean cut-out, and was concluded further refinement of the method may produce a useful relationship (Price et al. 1960). Other researchers found ultrasound rib-eye area and actual rib-eye area had low correlations, however, they were significant. These relationships were higher for hogs than for cattle and warranted additional refinement of the described technique in order to increase resolution and simplify evaluation of the results (Stouffer et al. 1961).

Research conducted in the 1960's found improvement in correlations utilizing ultrasound to measure backfat thickness and longissimus muscle (Davis et al., 1964; Hedrick et al., 1962;

Moody and Zobrisky, 1966). Researchers in the 1980's concluded as technology and experience improved, ultrasound accuracy did as well (Wood et al., 1986).

Scanogram equipment provided a good description of the subcutaneous fat layer and the muscle area (Andersen, 1975). Scanogram estimation of fat thickness agreed with carcass measurements at each scanning site, and correlations between scanogram estimates by two interpreters were found to be highly significant for all measurements, indicating the scanning scope was a useful tool in estimating carcass quality of beef cattle in a live state (Harada and Kumazaki, 1979).

The majority of the literature addressing ultrasonic measurements on cattle seems to indicate fat measurements were related to carcass fat thickness and the carcass composition (Andersen, 1975). However, the cross-sectional muscle picture is not of a similar quality with this equipment (Andersen, 1975). The correlations between ultrasonic and carcass muscle area vary considerably from experiment to experiment (Andersen, 1975). Others concluded utilizing real-time ultrasound to measure loin muscle area and fat depth at the 10th rib on the warm carcass appears to be nearly as good at predicting lean muscle mass as actual measurements made on the chilled carcass (Forrest et al., 1987).

Breeding Animals. As the use of real time ultrasound increased, accuracy for predicting carcass fat thickness and rib-eye area increased (Stouffer and Cross, 1985). This information has encouraged researchers to reinvestigate the use of ultrasound. Preliminary results indicate real-time ultrasonic devices may be useful in evaluating the composition of

seed stock animals, and with proper engineering and adaption, ultrasound may also be useful in evaluating carcasses on the slaughter line (Forrest et al., 1987).

A ultrasonic study grading live lambs was found to be sufficiently accurate ($r = .80$) in estimating carcass grade of potential flock replacements (Ramsey et al., 1987). In most recent studies utilizing swine, researchers were successful with relatively high correlations (Robinson et al., 1987; Lopes et al., 1987; Kreider et al., 1986; McMillian et al., 1987). Ultrasound should prove to be a useful tool in early selection for carcass merit, and in selecting for replacement gilts (Park et al., 1988; McLaren et al., 1988). In one study, data indicated ultrasound backfat thickness measurements were related to condition score and to weight to height ratio within breeds, but not over diverse cattle types (Comstock et al., 1986).

Accuracy. Errors in ultrasonic evaluation of live cattle, resulting in decreased accuracy in predicting lean and fat, were found to be due to animal variation, tissue change during slaughter, interpretation, and machine manipulation (Temple et al., 1965). A recent study with cattle has concluded ultrasonic readings tend to over estimate fat thickness, and under estimate loin-eye area (McMillian et al., 1987). Another study utilizing cattle indicated ultrasound over estimated fat thickness in lean cattle and under estimated fat thickness in fat cattle (Parrett et al., 1987). A study utilizing hogs concluded ultrasound under estimated backfat thickness and over estimated loin-eye area when compared to chilled pork carcasses (Kreider et al., 1986). Very firm or fat animals were also found to be difficult to sonascope (Temple et al., 1965). Probable factors accounting for low relationships between ultrasonic and carcass measurements are: positional variation of rib-eye area, and fat thickness between 12th and 13th ribs; changes of shape and size of rib-eye area due to slaughter; and hanging and variability in pressure of the transducer against

the hide during probing (Stouffer et al., 1961). However, contrary to those findings, changes in muscle area during slaughter and chilling are not major sources of error in ultrasonic evaluations, however, changes in fat and muscle configurations make interpretation of sonograms more difficult (Ramsey et al., 1965). Accuracy is greatly dependent upon interpretation (Lopes et al., 1987). Research is currently in progress at universities to find the technology which will allow for accurate determination of composition on both live animals and carcasses (Forrest et.al., 1987). Averaging measurements made by two operators increased correlations, and as the experience in operating a particular machine increased, accuracy increased (Wood et al., 1986). Before ultrasonography can be used as a tool to accurately measure back fat and longissimus muscle, the technician must be aware of the anatomy of the species measured, be trained in the use of the equipment, including calibration, ensure a good back-up service, carry out periodic checks against carcass measurements or, when this is not feasible, against similar machines (Andersen et al., 1983).

Ultrasound permits a non invasive evaluation of the internal structure of livestock (Pechman and Eilts, 1986). With additional refinement and experience, real-time ultrasound offers the potential to become a useful tool to evaluate livestock (Rouse and Parrish, 1987).

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FEEDLOT PERFORMANCE AND CARCASS TRAITS OF FEEDER CATTLE SORTED BY HIP HEIGHT AND BACKFAT WITH THE AID OF ULTRASONOGRAPHY

Abstract

Seven hundred and six percentage and purebred Shorthorn steers were utilized to determine the influence of hip height (HH), and backfat (BF) on feedlot performance and carcass traits. The steers were sorted by HH into 2 groups [small frame (SF) $\leq$ 118 cm., large frame (LF) > 118 cm]. Steers were sorted by BF within HH, utilizing ultrasonography into 3 groups [heavy condition (HC) $\geq$ .4 cm, average condition (AC) = .3 cm, light condition (LC) $\leq$ .2 cm]. The steers were slaughtered after reaching 1.0 cm of BF or 591 kg. Steers were slaughtered following 83, 91, 91, 97, 104 and 104 days-on-feed (DOF) for SF-HC, SF-AC, LF-HC, LF-AC, SF-LC, and LF-LC, respectively. Days on feed, average daily gain (ADG) and cost of gain (COG) increased (P<.001) with increases in steers HH. As BF increased, ADG and COG increased while DOF decreased (P<.001). Yield grade (YG), marbling (MB) and COG increased numerically (P<.05) with increased DOF. Steers with increased BF at slaughter had higher MB scores (P<.001). Average BF at slaughter by pen ranged from .9 to 1.1 cm $\pm$.23-.33 cm. DOF among pens varied by 21d, however, YG and MB were similar for all pens (2.7-3.1) and small 07-40, respectively. We conclude that feedlot performance and carcass characteristics of cattle are influenced by hip height and backfat of feeder cattle and that sorting of feeder cattle by hip height and backfat should result in increasing uniformity of performance and carcass characteristics of cattle.

(Key words: ultrasound, feedlot performance, carcass traits, sorting)

Introduction

The effects of body size and condition on beef production efficiency are not new topics. Feedlots should identify groups of cattle that will maximize efficiency and at the same time produce carcasses of similar weight with desirable yield and quality grades. Several studies have shown as cattle fatten, efficiency of feed utilization declines (Hedrick, 1972; Dikeman, 1973). Identifying the appropriate carcass-fat level is one key to optimizing carcass desirability while minimizing nutrient input (Parrett et al., 1985). A better understanding of the effect of frame size on postweaning growth, feed efficiency and carcass merit are necessary to evaluate net efficiency (Smith, 1979).

The objectives of this experiment were to study the effects of sorting feedlot cattle by hip height and backfat on performance, cost-of-gain, and carcass characteristics of beef steers.

Materials and Methods

Animals and Management. Seven hundred and six percentage Shorthorn steers (436-446 days of age, and average weight of 319-380 kg) were utilized to determine the influence of hip height, and backfat on feedlot performance and carcass traits. Steers were received into a commercial feedlot where they were individually weighed, measured for hip height with backfat between the 12th and 13th rib determined by utilizing a real-time, B-mode, diagnostic ultrasound scanner[1], equipped with a linear-array, 5-MHz transducer. The steers were sorted by hip height into two groups [small frame $\leq$ 118 cm, and large frame > 118 cm], sorted by backfat within hip height into three pen groups [heavy condition $\geq$ .4 cm, average condition = .3 cm, light condition $\leq$ .2 cm]. All steers were subjected to the same

[1]Equisonics LS-300 Corporation, Bensville, Il.

management and feeding program for the duration of the trial. Feed conversion by pen, gain, and days-on-feed by pen were recorded. Steers were slaughtered when the pen averaged 1.0 cm of backfat or 591 kg live weight. This was determined by ultrasonically measuring a 15% random sample from each pen following 75, 85 and 100 days-on-feed. Cattle were slaughtered at a commercial packing plant. Following slaughter, carcasses were chilled at 1 C for approximately 22 hr and evaluated for yield and quality grades by an experienced grader.

Statistical Analyses. Differences in average-daily-gain, yield grades, hot carcass weight, kidney knob, loineye area, marbling, and fat thickness were analyzed using the General Linear Model procedure of SAS (1985). All data are least-squares means, and because the number of steers among groups were unequal, approximated standard errors (Milliken and Johnson, 1984) were used for data presentation.

Results and Discussion

Feedlot Performance. Performance characteristics of treatment groups are shown in Table 1 and the effects of frame and body condition are shown in Table 2. Steers were slaughtered following 83, 91, 91, 97, 104, and 104 days-on-feed (DOF) for small frame-heavy condition (SF-HC), small frame-average condition (SF-AC), large frame-heavy condition (LF-HC), large frame-average condition (LF-AC), small frame-light condition (SF-LC), and large frame-light condition (LF-LC), respectively. These results would agree with Smith et al., (1977) who indicated that increasing time-on-feed was associated with increase of fatness, with small frame steers being fatter than the large frame. Also in agreement, Long (1988) reported that the larger the frame size, the longer the feeding period required to reach slaughter condition. Steers having more DOF had increased marbling scores

(P<.007). This agrees with the results of Parrett et al., (1985) who reported that as length of feeding period increased, percentage of carcasses grading Choice increased as well.

An interaction (Table 2) between frame and body condition influenced average daily gain (ADG) (P<.05). LF-LC steers gained faster (P<.05) than all treatment groups except LF-AC. LF-AC steers gained at faster rates than SF-LC, SF-AC and SF-HC steers (P<.05) (Table 1). This result could be partially explained by the fact the LF-LC and LF-AC steers were taller and leaner than SF steers at the beginning of the trial, and a potential compensatory gain effect may have influenced ADG. As initial hip height and backfat increased, ADG increased (P<.006) as well. This partially agrees with the results of Parrett et al., (1985) that showed leaner cattle were more efficient and had greater ADG, and Smith (1979) showed that large, late-maturing breeds gained more rapidly postweaning and were leaner at a constant age or weight end point than smaller breeds. The small differences in ADG are probably due to the fact that we marketed the treatment groups at a constant end point.

Carcass Characteristics. Carcass traits of treatment groups are shown in Table 3 and the effects of frame and body condition are shown in Table 4. Large frame steers had heavier hot carcass weights than the SF groups (P<.05) (Table 4). Even with the desired end point of 1 cm there were some slight differences in final fat thickness. The SF-LC, LF-LC and LF-AC steers were leaner (P<.05) than the other treatments, with SF-HC and LF-HC steers were carrying the greatest amount of fat thickness (P<.05) (Table 3). HC steers had more fat thickness than LC and AC steers (P<.0002) (Table 4). Identifying fat thickness as a market endpoint is one method of minimizing over fattening of cattle, and fat level is a useful marketing indicator because it can accurately predict palatability and cutability, and does influence carcass chilling (Dikeman and Kemp, 1981).

Our results agree with previous results (Long, 1988) which has shown large animals gain faster, mature larger and fatten less at equal weights than smaller animals.

LF-LC and LF-AC steers had the largest loin-eye areas ($p<.05$) and SF-LC steers had the smallest loin-eye areas (Table 3). Kidney, pelvic and heart-fat percentages were highest ($P<.05$) for LF-HC, SF-AC, and SF-LC groups, with the SF-HC steers being lower than the other groups ($P<.05$) (Table 3). There is no explanation as to why the SF-HC steers had the lowest percentages while the LF-HC had the highest percentage of kidney, pelvic and heart fat.

Yield grade was calculated from the U.S.D.A. formula. The LF-HC and SF-LC steers had the least desirable ($P<.05$) yield grades, with the LF-LC, SF-AC, and SF-HC were all alike and the LF-AC steers had the lowest most desirable yield grades (Table 3). Increased DOF adversely influenced yield grades ($P<.05$) by causing yield grades to increase. In agreement extending the feeding period where the potential for fat deposition is increasing rapidly will result in progressively lower yield of salable retail cuts and a progressively higher yield of fat (Hedrick, 1972).

There was not a great deal of difference between groups in quality grade, with all groups grading low choice, but differences did occur ($P<.05$) in marbling scores. The LF-LC, SF-LC, and LF-AC groups had the highest scores, while the SF-AC group had the lowest marbling scores (Table 3). LC groups had higher marbling scores than the AC or the HC groups ($P<.0002$) (Table 4). However, steers with greater backfat at slaughter had higher marbling scores ($P<.001$), but it was determined that increasing backfat beyond .9 cm did not improve marbling scores ($P<.01$).

In conclusion, these data indicate performance during the finishing phase and carcass characteristics of cattle are influenced by hip height and backfat of feeder cattle.

Therefore, the sorting of feeder cattle by hip height and backfat should result in optimizing and increasing uniformity in performance and carcass characteristics of cattle.

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TABLE 1. LEAST SQUARE MEANS OF PERFORMANCE CHARACTERISTICS OF FEEDER STEERS BY FRAME AND BODY CONDITION

Item	Light condition[1]		Average condition[1]		Heavy condition		SE
	Sm[2]	Lg[3]	Sm[2]	Lg[3]	Sm[2]	Lg[2]	
Number	128	83	172	165	84	74	
Initial hip height, cm	114.5	121.25	115.19	121.36	115.21	127.9	
Initial backfat, cm	.2	.2	.3	.3	.4	.4	
Days on feed	104	104	91	97	83	91	.06
Average daily gain, kg	1.7[a]	1.95[b]	1.74[a]	1.87[bc]	1.77[a]	1.79[ac]	.04
Cost of gain, dollars	35.5	33.7	35.7	35.7	37.0	36.8	.8

[1]Light condition ≤ .2 cm, average condition = .3 cm, heavy condition ≥ .4 cm of backfat at start of trial.

[2]Sm denotes small framed cattle with hip heights ≤ 118 cm on start on trial.

[3]Lg denotes large framed cattle with hip heights > 118 cm on start of trial.

[abc]Least square means within a row without a common superscript differ ($P < .05$).

TABLE 2. EFFECTS OF FRAME AND BODY CONDITION AT THE START OF THE TRIAL ON PERFORMANCE CHARACTERISTICS

Item	Frame		SE	Body condition			SE
	Sm[2]	Lg[3]		Light[1]	Average[1]	Heavy[1]	
Average daily gain[ab], kg	1.75	1.87	.02	1.86	1.82	1.77	.03
Cost of gain, dollars/cwt	36.0	35.4	.5	35.7	34.6	36.9	.6

[1]Light condition $\leq$ .2 cm, average condition = .3 cm, heavy condition $\geq$ .4 cm of backfat at start of trial.

[2]Sm denotes small framed cattle with hip heights $\leq$ 118.11 cm at start of trial.

[3]Lg denotes large framed cattle with hip heights > 118.11 cm at start of trial.

[a]Significant body condition effect ($P < .01$).

[b]Significant body condition x frame effect ($P < .05$).

TABLE 3. LEAST SQUARE MEANS OF CARCASS TRAITS OF FEEDER STEERS SORTED BY FRAME AND BODY CONDITION

Item	Light condition[1]		Average condition[1]		Heavy condition		SE
	Sm[2]	Lg[3]	Sm[2]	Lg[3]	Sm[2]	Lg[2]	
Hot carcass weight, kg	311^{a}	345^{b}	310^{a}	343^{b}	313^{a}	339^{b}	2.5
Fat thickness, cm	1.01^{ab}	$.99^{ab}$	1.03^{bc}	$.95^{a}$	1.10^{cd}	1.11^{d}	.03
Loin-eye area, cm^2	72.9^{a}	80.6^{c}	76.1^{b}	80.0^{c}	75.5^{ab}	77.4^{b}	.8
Kidney knob, %	2.3^{cd}	2.2^{c}	2.3^{d}	1.7^{b}	1.4^{a}	2.4^{d}	.05
Yield grade	2.9^{cd}	2.8^{bc}	2.8^{b}	2.7^{a}	2.8^{ab}	3.1^{d}	.5
Marbling score	$Sm^{32\ b}$	$Sm^{32\ bc}$	$Sm^{07\ a}$	$Sm^{22\ bc}$	$Sm^{20\ bc}$	$Sm^{18\ ac}$	5.0

[1]Light condition ≤ .2 cm, average condition = .3 cm, heavy condition ≥ .4 cm of backfat at start of trial.

[2]Sm denotes small framed cattle with hip heights ≤ 118 cm at start of trial.

[3]Lg denotes large framed cattle with hip heights > 118 cm at start of trial.

[abcd]Least square means within a row without a common superscript differ ($P < .05$).

TABLE 4. EFFECTS OF FRAME AND BODY CONDITION AT THE START OF THE TRIAL ON CARCASS CHARACTERISTICS

Item	Frame			Body condition			
	Sm[2]	Lg[3]	SE	Light[1]	Average[1]	Heavy[1]	SE
Hot carcass weight[b], kg	311[d]	342[e]	1.5	328	326	326	1.8
Fat thickness[a], cm	1.02	1.05	.02	1.0[d]	.99[d]	1.10[e]	.02
Loin eye area[bc]	74.8	79.3	.5	76.8	78.1	76.1	.6
Kidney knob[ac], %	2.0	2.1	.03	2.2	2.0	1.9	.04
Yield grade[c]	2.8	2.9	.3	2.9	2.7	2.9	.4
Marbling score[a]	Sm^{20}	Sm^{24}	2.9	Sm^{32}	Sm^{15} [d]	Sm^{19} [d]	3.5

[1]Light condition ≤ .2 cm, average condition = .3 cm, heavy condition ≥ .4 cm of backfat at start of trial.

[2]Sm denotes smaller framed cattle with hip heights ≤ 118.11 cm at start of trial.

[3]Lg denotes larger framed cattle with hip heights > 118.11 cm at start of trial.

[a]Significant body condition effect ($P < .0002$).

[b]Significant frame effect ($P < .0001$).

[c]Significant body condition x frame effect ($P < .05$).

[de]LS means within a row without a common superscript differ ($P < .05$).

THE USE OF ULTRASOUND IN CATTLE TO ESTIMATE SUBCUTANEOUS FAT THICKNESS AND RIBEYE AREA

Abstract

Two hundred and twenty seven steers of mixed breeding were utilized in six trials to determine the relationship of ultrasound measurements to carcass measurements of backfat (BF), and ribeye area (REA). Five measurements of REA were not recorded, therefore are not included in the analysis. A real-time, B-mode, diagnostic ultrasound scanner, equipped with a linear-array, 3-MHz transducer was used. BF, and REA were measured between the 12th and 13th ribs on the left side. The image for each BF observation was "frozen" on the screen, and measured by internal electronic calipers at the time of scanning. REA image was recorded and stored on a video cassette for latter playback on a television screen. The animals were slaughtered within 7 d following scanning. Carcasses were chilled at 1 C for 22 h. BF and REA measurements were taken on the left side. Simple correlations between ultrasonic measurements at two locations and the corresponding carcass measurements were .85 ($P<.02$), and .71 ($P<.0001$) for BF and REA respectively. Ninety three percent of the ultrasound BF measurements were within .3 cm of the carcass measurements. Ultrasonic REA measurements were not as closely related with carcass measurements, only seventy six percent were within 6.45 sq. cm. Least square means of BF in the 6 trials showed no differences in ultrasound measurements when compared to carcass measurements ($P > .19$). There was no difference in least square means ($P > .24$) for REA in trials 1, 4, 5 and 6, but ultrasound slightly underestimated REA in trials 2, and 3, when compared to carcass measurements ($P < .005$). These data indicate

ultrasonic scans on live beef cattle with real time linear-array equipment may prove beneficial to the cattle industry for predicting carcass BF and REA.

(Key words: ultrasound, cattle, backfat, ribeye area)

Introduction

Ultrasound is one of the fastest growing technologies in the beef industry and could allow producers to objectively and effectively evaluate carcass composition in live animals prior to slaughter. It is presently being used to determine subcutaneous backfat thickness and rib eye area between the 12th and 13th ribs. It is possible that ultrasonic scanning of cattle could speed up progeny testing and eliminate much of the labor and expense associated with collection of carcass data at slaughter (Davis et al., 1964; Forrest et al., 1987; Hedrick et al., 1962; McLaren et al., 1988).

Ultrasound equipment consists of a pulse generator and a transmitter-receiver probe (transducer). Operating much like sonar, ultrasound is based on the principle that high frequency sound will transmit through most liquid and solid materials such as muscle, and fat (Rantanem et al., 1981).

The objective of this study was to evaluate the relationship between ultrasonic, and carcass measurements of subcutaneous fat thickness and longissimus muscle area.

Materials and Methods

Animals and Management. Two hundred and twenty-seven steers of mixed breeding (13 to 24 mo of age) were evaluated in six trials utilizing ultrasound equipment. Five measurements of the loin-eye area were not recorded, therefore only 222 measurements of the loin-eye area were utilized. A real-time, B-mode, diagnostic ultrasound scanner[2],

[2]Equisonics LS-300 Corporation, Bensville, Il.

equipped with a linear-array, 3-MHz transducer was used for these examinations. Fat thickness depth, and longissimus muscle area were measured on the left side.

The image for each fat thickness observation was "frozen" on the screen, and measured by internal electronic calipers at the time of scanning. The use of calipers for fat thickness increases accuracy (Lopes et al., 1987). Image of the longissimus muscle from the ultrasound screen was recorded, and stored on a video cassette for later playback on a regular television screen. The longissimus muscle was then traced on acetate paper and measured by electronic planimeter. The animals were slaughtered within 7 d following scanning. Carcasses were chilled at 1 C for approximately 22 h. Tracings of longissimus muscle were taken from the left side using tracing paper and were later measured using electronic planimeter. Back fat measurements were also taken from the left side.

Statistical Analyses. Differences in backfat and loineye area were analyzed using the General Linear Model procedure of SAS (1985). Cumulative frequencies were analyzed using the frequency procedure of SAS (1985).

Results and Discussion

The least square means and standard errors of ultrasonic measurements of fat thickness are shown in Table 1. The results showed no difference in means in all six trials (P>.19) when comparing ultrasound measurements with carcass measurements. Previous research has reported using average ultrasound measurements is more accurate in predicting carcass fat thickness measurements than using individual measurements (Wood et al., 1986). Some of our results would agree with McMillian et al., (1987) who reported that ultrasound fat thickness overestimated actual fat thickness. Parrett et al. (1987), reported that ultrasound tended to overestimate lean cattle and underestimate fat cattle. Errors in ultrasonic evaluation of live cattle, resulting in decreased accuracy in predicting lean and

fat, were found to be due to animal variation, tissue change during slaughter, interpretation, and machine manipulation (Temple et al., 1965).

The least square means and standard errors for ultrasound loin-eye measurements are shown in Table 2. In trials one, four, five, and six there was no difference in means (P>.24) when comparing ultrasound with carcass measurements, but in trials two and three, ultrasound slightly underestimated loin-eye area when compared to carcass measurements (P<.005). These results agree with previous research that reported ultrasound loin-eye area in cattle underestimated carcass loin-eye area (McMillian et al., 1987). However, Kreider et al. (1986), reported that ultrasound overestimated loin-eye area in chilled pork carcasses. Advancement in technology has allowed accuracy to increase by increasing resolution of more tissue density, and to allow the operator to observe movements as they occur.

Simple correlation coefficients between ultrasonic estimates at two locations and the corresponding carcass measurements are presented in Table 3. For the 6 trials highly significant correlations (P<.02) were found between the ultrasonic measurements, and the carcass measurements of fat thickness and the longissimus muscle area taken between the 12th and 13th ribs (r=0.85 and 0.71, respectively). Campbell et al. (1959), found significant correlations between ultrasonic and actual loin-eye area in lambs, and others reported significant correlations (r=0.32 to 0.90) of ultrasonic measurements of live cattle to carcass measurements (Davis et al. 1964; Hedrick et al. 1962; Stouffer et al. 1961; and Price et al. 1960). In our study, correlations for fat thickness tended to improve in subsequent trials. This agreed with Wood et al. (1986), who reported that as operator experience increased in operating a particular machine, accuracy of estimates increased.

Cumulative frequency percent for the ultrasonic, and carcass fat thickness and rib-eye area measurements are shown in Table 4. Ultrasonic fat measurements were very

closely related to the carcass measurements. Ninety three percent of ultrasound fat thickness measurements were within .3 cm of the carcass measurement. Ultrasonic rib-eye measurements were not as closely related with carcass measurements, only seventy six percent were within 6.54 sq. cm. Turlington reported (unpublished data) similar results in frequency comparison when comparing ultrasound fat thickness in hogs to carcass measurements. One hundred percent of the time ultrasound was within .25 cm of carcass measurements and ninety-five percent of the time ultrasound loin-eye measurements in hogs were within 1.61 sq cm of carcass measurements. Cumulative frequency may have more value in accounting for accuracy than simple correlations. It accounts for variability and shows values by location.

Graders could not rank individual animals on the basis of either quantitative or qualitative carcass traits with the precision necessary for selecting among individuals. They concluded a more precise measurement of differences among individuals were needed (Gregory et al., 1964). Therefore in conclusion, these data indicate ultrasonic scans on live beef cattle with real-time linear-array equipment appears to be a good indicator for predicting carcass backfat and loin-eye area and may be a useful tool to evaluate livestock.

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TABLE 1. COMPARISON OF LEAST SQUARES MEANS OF ULTRASOUND BACKFAT AND CARCASS BACKFAT MEASUREMENTS

Group	Item[a]	LS Mean Ultrasound	LS Mean Carcass[b]	SE
1	UBF vs CBF	.96	.79	.09
2	UBF vs CBF	1.04	1.02	.07
3	UBF vs CBF	1.17	1.10	.05
4	UBF vs CBF	1.04	1.05	.05
5	UBF vs CBF	1.11	1.11	.05
6	UBF vs CBF	.92	.94	.06

[a]UBF = Ultrasound backfat, CBF = Carcass backfat.
[b]Backfat is listed in cm.

TABLE 2. COMPARISON OF LEAST SQUARES MEANS OF ULTRASOUND LOIN-EYE AREA AND CARCASS LOIN EYE-AREA MEASUREMENTS

Group	Item[a]	LS Mean Ultrasound	LS Mean Carcass[b]	SE
1	ULEA vs CLEA	82.6	86.3	2.2
2	ULEA vs CLEA[c]	65.1	72.5	1.85
3	ULEA vs CLEA[c]	79.2	83.8	1.15
4	ULEA vs CLEA	75.2	75.0	1.18
5	ULEA vs CLEA	75.2	76.9	1.15
6	ULEA vs CLEA	72.9	74.8	1.46

[a]ULEA = ultrasound loin-eye area, CLEA = carcass loin-eye area.
[b]Loin-eye area is listed in cm^2.
[c]Significant difference between ultrasound and carcass measurement ($P<.005$).

TABLE 3. SIMPLE CORRELATION COEFFICIENTS BETWEEN TWO ULTRASONIC ESTIMATES AND THE CORRESPONDING TWO CARCASS MEASUREMENTS

Group	Item[a]	Observations	Correlations
1	UBF vs CBF	14	0.66*
	ULEA vs CLEA	14	0.76**
2	UBF vs CBF	21	0.50*
	ULEA vs CLEA	20	0.32
3	UBF vs CBF	55	0.82***
	ULEA vs CLEA	52	0.68***
4	UBF vs CBF	50	0.92***
	ULEA vs CLEA	49	0.76***
5	UBF vs CBF	55	0.88***
	ULEA vs CLEA	55	0.79***
6	UBF vs CBF	32	0.88***
	ULEA vs CLEA	32	0.45*

*(P<.02)
**(P<.01)
***(P<.001)
[a]UBF = Ultrasound backfat, CBF = Carcass backfat, ULEA = Ultrasound loin-eye area, CLEA = Carcass loin-eye area.

TABLE 4. FREQUENCY COMPARISON OF DIFFERENCES BETWEEN ULTRASOUND MEASURED BACKFAT AND LOIN-EYE AREA TO CARCASS BACKFAT AND LOIN-EYE AREA

± cm	BF[a] Cumulative %	± cm^2	LEA[b] Cumulative %
.10	56	3.22	37
.20	81	6.45	76
.30	93	9.68	85
.40	99	12.9	92
		16.1	96

[a]BF = Backfat.
[b]LEA = Loin-eye area.

APPENDICES

APPENDIX TABLE 1. INITIAL MEASUREMENTS, WEIGHTS AND CARCASS CHARACTERISTICS

Tag	Pen	Initial hip height, in.	Initial backfat, in	Starting wt, lbs	Hot carcass wt, lbs	Maturity	Marbling score	Ending wt, lbs	Ending fat thickness in	Kidney knob, %	Loineye area, sq. in	Yield grade	Warner Bratzler shear
009	1	42.3	.08	562	597	160	510	899	.45	3.5	9.4	3.6	3.5
101	1	43.0	.12	676	690	160	390	1104	.40	2.5	11.7	2.9	3.4
137	1	48.3	.16	820	730	160	330	1168	.60	1.0	11.8	3.2	3.9
142	1	47.3	.16	664	721	150	270	1154	.65	2.0	10.9	3.8	3.7
165	1	48.8	.08	788	720	140	390	1152	.35	2.5	13.2	2.4	3.5
177	1	46.0	.08	678	705	150	320	1128	.35	2.0	11.2	2.9	2.6
193	1	44.3	.08	676	724	150	530	1158	.55	2.5	9.5	4.1	2.4
225	1	45.8	.12	726	688	140	330	1101	.40	2.0	10.3	3.2	3.0
249	1	47.3	.12	718	676	130	350	1082	.40	2.5	10.8	3.1	3.8
437	1	48.0	.12	908	882	160	360	1411	.55	1.5	14.7	2.8	3.3
439	1	46.0	.16	814	709	150	310	1134	.35	1.5	13.5	2.0	3.5
487	1	45.3	.12	954	781	150	230	1250	.35	2.5	14.0	2.4	2.7
505	1	47.3	.16	866	774	150	330	1238	.30	2.0	12.1	2.7	4.0
560	1	46.5	.12	728	686	150	290	1098	.40	1.5	11.0	2.9	4.3
561	1	45.0	.12	668	726	170	340	1162	.50	2.0	12.2	3.0	3.0
608	1	47.3	.08	848	763	160	380	1221	.45	2.5	11.4	3.4	2.5
613	1	44.3	.12	724	686	170	310	1098	.55	2.0	11.0	3.4	3.3
617	1	48.0	.12	812	765	160	340	1224	.45	2.0	11.0	3.4	3.3
623	1	44.8	.12	674	608	130	330	973	.50	3.0	10.4	3.3	2.9
640	1	46.0	.08	844	749	140	340	1198	.45	3.0	12.7	3.0	4.6
685	1	46.8	.16	794	756	160	340	1210	.55	2.0	12.8	3.1	4.3
709	1	47.0	.12	896	886	170	270	1418	.50	1.5	12.1	3.5	3.8
761	1	46.5	.16	814	721	130	300	1154	.35	2.0	13.7	2.1	3.9
788	1	48.5	.12	764	743	140	310	1189	.35	2.5	11.8	2.9	2.8
042	2	45.0	.08	644	726	150	340	1162	.55	2.0	11.9	3.2	3.5
062	2	46.0	.12	696	689	150	330	1102	.55	2.5	10.4	3.7	3.1
092	2	45.8	.08	644	695	150	380	1112	.55	2.5	09.7	3.9	3.5
107	2	43.5	.16	730	710	160	350	1136	.45	1.5	11.6	2.9	3.2
114	2	42.8	.12	638	693	160	440	1109	.60	2.0	10.1	3.8	3.6
146	2	45.3	.12	690	697	150	330	1115	.40	2.5	11.8	2.9	2.7
160	2	47.0	.08	814	678	130	240	1085	.30	2.0	12.8	2.1	3.6

APPENDIX TABLE 1 (continued)

Tag	Pen	Initial hip height, in.	Initial backfat, in	Starting wt, lbs	Hot carcass wt, lbs	Maturity	Marbling score	Ending wt, lbs	Ending fat thickness in	Kidney knob, %	Loineye area, sq. in	Yield grade	Warner Bratzler shear
414	2	47.0	.12	746	780	160	260	1248	.40	2.5	13.5	2.7	4.3
440	2	48.3	.12	832	763	140	320	1221	.30	3.0	11.6	3.0	3.3
450	2	48.3	.12	884	822	160	380	1315	.55	2.5	13.5	3.2	3.0
485	2	48.3	.08	928	788	140	380	1261	.45	2.5	12.3	3.2	3.1
503	2	47.0	.16	830	748	150	390	1197	.50	2.0	11.7	3.2	3.2
516	2	48.0	.12	782	718	130	290	1149	.35	3.0	14.4	2.1	3.2
537	2	47.0	.12	888	754	140	320	1206	.40	2.0	11.1	3.2	4.2
570	2	46.8	.16	838	759	150	270	1214	.35	2.0	12.0	1.9	3.9
590	2	46.5	.12	780	727	150	310	1163	.30	2.5	14.5	1.9	3.2
603	2	47.5	.16	892	734	160	240	1174	.45	2.5	11.9	3.1	4.0
624	2	46.0	.12	788	705	150	340	1128	.35	2.5	11.5	2.9	3.4
691	2	46.3	.16	866	715	160	360	1144	.40	1.5	11.8	2.7	3.8
695	2	45.3	.16	810	760	170	330	1216	.45	2.0	13.0	2.8	3.6
697	2	44.3	.12	696	693	140	380	1109	.55	2.0	12.0	3.1	2.6
711	2	48.3	.16	999	851	170	350	1362	.50	1.0	11.4	3.5	4.0
722	2	45.0	.12	800	707	140	370	1131	.55	3.0	10.9	3.7	3.4
826	2	44.0	.16	840	758	150	330	1213	.40	2.0	11.7	3.0	3.2

FEEDLOT PERFORMANCE AND CARCASS TRAITS OF FEEDER CATTLE SORTED BY HIP HEIGHT AND ULTRASOUND DETERMINED BACKFAT

by

SUSAN CAROL HENDERSON-PERRY

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Seven hundred and six percentage Shorthorn steers were utilized to determine the influence of hip height (HH), backfat (BF) on feedlot performance and carcass traits. The steers were sorted by HH into 2 groups [small frame (SF) $\leq$ 118 cm., large frame (LF) > 118 cm]. Steers were sorted by BF within HH, utilizing ultrasonography into 3 groups [heavy condition (HC) $\geq$ .4 cm, average condition (AC) = .3 cm, light condition (LC) $\leq$ .2 cm]. The steers were slaughtered after reaching 1.0 cm of BF or 591 kg. Steers were slaughtered following 83, 91, 91, 97, 104 and 104 days-on-feed DOF for SF-HC, SF-AC, LF-HC, LF-AC, SF-LC, and LF-LC, respectively. Days on feed, average daily gain (ADG) and cost of gain (COG) increased (P<.001) with increases in steers HH. As BF increased, ADG and COG increased while DOF decreased (P<.001). Yield grade (YG), marbling (MB) and COG increased numerically (P<.05) with increased DOF. Steers with increased BF at slaughter had higher MB scores (P<.001). Average BF at slaughter by pen ranged from .9 to 1.1 cm $\pm$.23-.33 cm. DOF among pens varied by 21 d, however, YG and MB were similar for all pens (2.7-3.1) and small 07-40, respectively. Two hundred and twenty seven steers of mixed breeding were utilized in 6 trials to determine the relationship of ultrasound measurements to carcass measurements of backfat (BF), and ribeye area (REA). Five measurements of REA were not recorded, therefore only two hundred and twenty two measurements of the REA were utilized. A real-time, B-mode, diagnostic ultrasound scanner, equipped with a linear-array, 3-MHz transducer was used. BF, and REA were measured between the 12th and 13th rib on the left side. The image for each BF observation was frozen on the screen, and measured by an internal electronic calipers at the time of scanning. REA image was recorded and stored on a video cassette for latter playback on a television screen. The animals were slaughtered within 7 d following scanning. Carcasses were chilled at 1 C for 22 h. BF and REA measurements were taken on the left side. Simple correlations between ultrasonic measurements at two locations and

the corresponding carcass measurements were .85 ($P<.02$), and .71($P<.001$) for BF and REA respectively. Ninety three percent of the time ultrasound BF measurements were within .3 cm of the carcass measurements. Ultrasonic REA measurements were not as closely related with carcass measurements, only seventy six percent were within 6.45 cm^2. Least square means of BF in he 6 trials showed no differences in ultrasound measurements when compared to carcass measurements ($P >.19$). There was no difference in least square means ($P >.24$) for REA in trials 1,4,5 and 6, but ultrasound slightly underestimated REA in trials 2, and 3, when compared to carcass measurements ($P <.005$). These data indicate ultrasonic scans on live beef cattle with real time linear-array equipment could prove useful in the cattle industry for predicting carcass BF and LEA.

(Key words: ultrasound, feedlot performance, carcass traits, sorting, cattle.)